Journal of Vocational and Automotive Engineering, Vol.1, No. 1, 2022 (8-12)

The Effect of Fuel Octane Value on Emission Levels in Manual (Four-Stroke) Motorcycles.

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Abstract. *This study aims to determine the effect of the octane value of the fuel on the emission level of a four-stroke motorcycle. The type of this research is Experimental Design with Factorial Experiment Research design with Two Factor Experiments in Completely Randomized Design. The four-stroke motorcycle used is a single-cylinder four-stroke motorcycle with a compression ratio of 9:1. Data analysis used descriptive statistical analysis with inferential statistics and sub-multivariate analysis of variance. The test was carried out with variations in engine speed of 1600 rpm, 3000 rpm, and 4500 rpm. Based on the results of the study, it was found that the exhaust emissions produced on four-stroke motorcycles using RON 88 fuel had the highest number of CO exhaust emissions at 1600 rpm and 4500 rpm, and HC at 1600 rpm, 3000 rpm, and 4500 rpm compared to RON 90 and RON 92. While the exhaust gas emissions of O2 RON 88 are lower at 1600 rpm and 3000 rpm compared to RON 90 and RON 92. The exhaust gas emissions of RON 90 are lower than RON 88 with the amount of CO and HC exhaust emissions. The exhaust gas emissions of O2 RON 90 are higher than RON 88. And the exhaust emissions produced by RON 92 in CO, HC, and CO2 exhaust gases are lower than on RON 88 and RON 90. The exhaust gas emissions of O2 on RON 92 are higher than on RON 88 and RON 90 but the exhaust emissions of O2 are not harmful. Hypothesis testing shows that there is a significant effect between the RON of fuel and CO and HC exhaust emissions. So, it can be concluded that fuels that have a high-octane rating tend to have a low amount of harmful exhaust emissions, namely CO and HC.*
***Keywords*— Fuel Octane Value, rpm (rotation per minute), Exhaust, Emissions.**

I. INTRODUCTION

The presence of a combustion engine as a result of modern technology provides a major contribution to help make it easier for humans to carry out activities in all fields, especially in the field of transportation which is generally coloured by motor fuels as a driving force, along with the development of time, of course, it requires more and more energy as well. Ade revealed that in 2016 the number of motorcycles in Makassar reached 1,128,809 units. The number of two-wheeled vehicles is far adrift compared to four-wheeled vehicles or more. The details are passenger cars (206,435 units), buses (17,264 units), freight cars (72,239 units), and special vehicles (403 units).

The most widely used motorcycle by the community today is the four-stroke motorcycle. Boentarto in Asthari (2006: 3) suggests that four-stroke motorcycles tend to be more fuel efficient when compared to two-stroke motorcycles with the same cylinder size. Four-stroke motors tend to use more efficient gasoline because each work process occurs in one full step.

Seeing the number of uses of four-stroke motorcycles affect the level of exhaust emissions. Exhaust gas HC (Hydro Carbon), and CO (Carbon Monoxide), impact caused by HC exhaust gases is to disturb and damage the human respiratory system and can trigger cancer, while CO if mixed with blood will result in Carbon Monoxide Haemoglobin (COHb) will block blood flow, if in the blood there is 5% COHb it will cause poisoning in the blood.

The problem that exists in the community is that many people use fuel (gasoline) that is not to the specifications of the engine of their vehicle. Using fuel that is not by the octane rating on a motorcycle engine, the combustion produced by the motor becomes imperfect. incomplete combustion can cause detonation which can cause a lot of toxic exhaust emissions. Seeing the importance of the above problems, the authors took the initiative to research the number of exhaust emissions based on the use of Premium, Pertalite, and Pertamax fuels on four-stroke motorcycles.

II. LITERATURE REVIEW

A. Definition of Fuel Motor

Daryanto (2004) argues that the heat that arises due to combustion in the combustion chamber, is what is used by the motor to produce the propulsion power of the motorcycle. On a motorcycle, power is obtained from the combustion of gasoline mixed with air in a combustion chamber which will then generate heat. This heat will be converted into mechanical energy in a motor called a combustion engine.

B. Definition of Four-Stroke Motors

A four-stroke motorcycle is a motorcycle that uses a motor four-stroke as the driving force. A four-stroke motor is a motor in which each cycle of work is completed in four strokes of the piston or two revolutions of the crankshaft. During the four strokes, the piston undergoes five processes, namely: intake of fuel and air (suction), compression, combustion, expansion/work, and exhaust.

C. Fuel

Fuel oil is an organic compound that is needed in combustion to obtain energy. Fuel oil is the result of the distillation process of petroleum into the desired fractions so that it becomes the energy needed by motorized vehicles to drive the shaft. The fuel oil produced by Pertamina and traded in Indonesia is as follows:

1. Gasoline, namely Premium, Pertalite, Pertamax, and Pertamax plus,
2. LPG and BBG (gas fuel),
3. Diesel oil,
4. Diesel Oil and e. Fuel oil.

Gasoline is one of the products produced from petroleum or crude oil. Gasoline is a mixture of hydrocarbon compounds containing 4 to 12 carbon atoms, in the form of a volatile liquid, making it suitable for use in spark-ignition motor vehicles.

D. Combustion Theory

Combustion is a very fast chemical reaction between fuel with oxygen which generates heat, resulting in high gas pressure and temperature. During the combustion process, fuel oil droplets into their component elements, namely hydrogen and carbon, will combine with oxygen to form carbon dioxide. If there is not enough oxygen, then some of the carbon will combine with oxygen to form carbon monoxide. Due to the formation of carbon monoxide, the amount of heat generated is only 30% of the heat generated by the formation of carbon monoxide as shown by the following chemical reaction:

Reaction enough oxygen : $C + O2 \rightarrow CO2 + 393$ kJ,

The reaction of lack of oxygen: $C + ½O2 \rightarrow CO + 110.5$ kJ.

An essential condition for efficient combustion is sufficient movement of the fuel and air, meaning that the distribution of the fuel and its mixing with the air must depend on the movement of the air called eddies.

E. Motor Vehicle Exhaust

Exhaust gases generally consist of non-toxic gases, N2 (nitrogen), CO2, O2 and H2O, a small portion of which are toxic gases such as HC, and CO. What is often questioned in the exhaust gas is the toxic gas released by the vehicle.

1) CO (Carbon monoxide), colourless and odourless. Not easily soluble in water, the ratio of weight to air (1 Atm c) is 0.967 in the air when given a fire, it will burn with blue smoke and become CO2. Derived from motor vehicles 93% power generator 7%, especially where the source is on the vehicle when idling. The consequences include mixing with haemoglobin in the blood to form Carbon Monoxide Haemoglobin (COHb). With the increase in COHb, the function of blood flow of oxygen in the blood will be hindered. If there is 5% COHb, it will cause poisoning in the blood.

2) HC (Hydro Carbon), is a chemical bond between carbon (C) and hydrogen (H). Its chemical form is divided into paraffine, naphthalene, olefine and aromatic N2O because it is not active, it is not a problem. Sources of cause include motor vehicles, 57% of oil refining and power generators 43%. The main source is exhaust gas from vehicles or various internal combustion devices and others, such as refining oil (oil refinery) due to the use of solvents. As a result, when the concentration of HC increases, it will damage the human respiratory system (throat), especially the toxic ones, namely benzene and toruene. Active Hydro Carbon such as composition (olefine and so on) will cause photochemical smoke (smoke is meant here as the arrangement of a collection of clusters between CO, HC and N2 which when exposed to sunlight will cause hot eyes). From the type of aromatic, there is also a cause of cancer.

F. Motor Vehicle (Motorcycle) Exhaust Emission Threshold

The exhaust emission threshold is regulated according to the Regulation of the State Minister of the Environment Number 05 of 2006 concerning the Exhaust Emission Threshold for

Old Motorized Vehicles, presented in the following table:

Table. 1
Motorcycle Exhaust Emission Threshold

Category	Production year	Parameter		Test Method
		CO (%)	HC (ppm)	
2 stroke motorbike	< 2010	4,5	12000	Idle
4 stroke motorbike	< 2010	5,5	2400	Idle
2 stroke motorbike	≥ 2010	4,5	2000	Idle

Source: Regulation of the State Minister of the Environment Number 05 of 2006.

III. RESEARCH METHODS

A. Research Flow

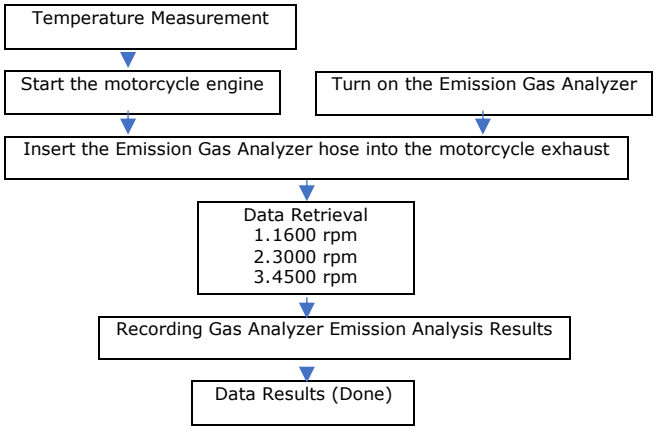

Figure. 1 Research Flow

B. Research procedure

The tools and materials used in this research are:

1) Tool

- Emission Gas Analyzer
- Tachometer
- Stopwatch
- Small hose 200 cm
- Digital Thermometer
- Workshop tools
- Stationery
- Documentation tools

2) Ingredient

- Motorcycle (Yamaha Xride 113 cc, Fuel Injection, 2014)
- Fuel (RON 88, RON 90 and RON 92).

C. Place and time of research

This research was conducted at the PT. Hadji Kalla, Branch Jl. Urip Sumohardjo. This research was conducted on March 26-April 26, 2018.

D. Research Implementation

The procedure for conducting the research is as follows:

- Putting Premium fuel into the motorcycle tank
- Start the motorcycle engine for 5 minutes
- Turn on the Emission Gas Analyzer tool for 5 minutes to find out if the tool is ready to operate
- Installing the Emission Gas Analyzer hose on the motorcycle exhaust
- Record the analysis results obtained from the Emission Gas Analyzer in each round
- After data collection is carried out by Premium fuel, then data is collected on Pertalite and Pertamax fuels.

IV. FINDINGS

A. CO Exhaust Emission Graph

The test results of CO exhaust emissions from the use of RON 88, RON 90 and RON 92 fuels are shown in the following graph:

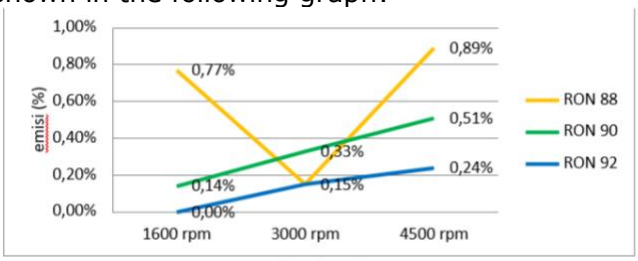

Figure. 2 CO Exhaust Emissions

Figure 2 shows the CO emission content of RON 88 fuel at 1600 rpm the exhaust gas emission content is the highest compared to RON 90 and RON 92, while at 3000 rpm the exhaust emission content of RON 88 fuel is lower than RON. 90 and the emission value is the same as RON 92 fuel. While at 4500 rpm the CO exhaust emission content of RON 88 fuel experienced a significant increase and was the highest value compared to RON 90 and RON 92. So, it can be concluded that the highest CO emission is RON 88 fuel, which is both RON 90 and the lowest is RON 92.

B. HC Exhaust Emission Chart

The test results of HC exhaust emissions from the use of RON 88, RON 90 and RON 92 fuels are shown in the following graph:

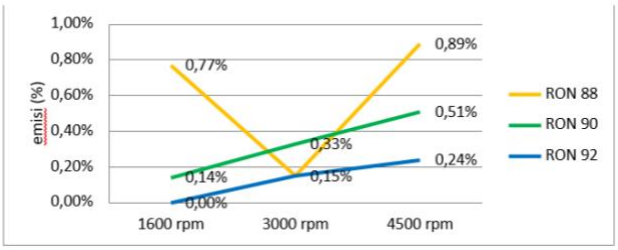

Figure. 3 HC Exhaust Emissions

Figure 3 shows that RON 88's HC exhaust emission content is the highest compared to RON 90 and RON 92. Meanwhile, RON 90 and RON 92 tend higher engine speeds, and HC exhaust emissions are higher as well. So, it can be concluded that the highest HC exhaust emissions are at RON 88, the second is at RON 90 and the lowest is at RON 92.

C. CO2 Exhaust Emission Graph

Test results of CO2 exhaust emissions from the use of RON 88 fuel

RON 90 and RON 92, are shown in the following graph:

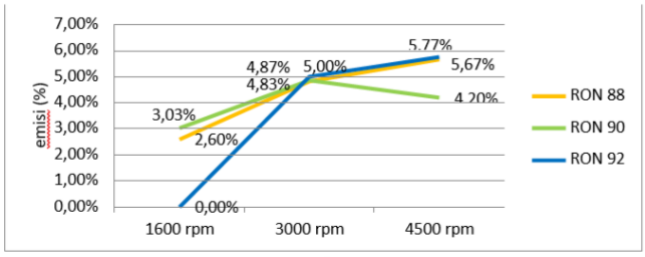

Figure. 4. CO2 Exhaust Emission Graph

Figure 4 shows that the CO2 emission content of fuel RON 88 and RON 92 tends to the higher in engine speed, the higher the exhaust gas emission content, while in RON 90 where at 1600 rpm the exhaust emissions are higher than RON 88 and RON. 92, at 3000 rpm the exhaust emissions are lower than RON 92 and higher than RON 88. So, it can be concluded that the highest CO2 emissions are RON 88 fuel, the second is RON 90 and the lowest is RON 92, but CO2 exhaust emissions are not dangerous because they are water vapour and gases needed for living things.

D. Graph of O2 Exhaust Emissions

The discussion of the results of the O2 exhaust emission test from the use of RON 88, RON 90 and RON 92 fuels is shown in the following graph:

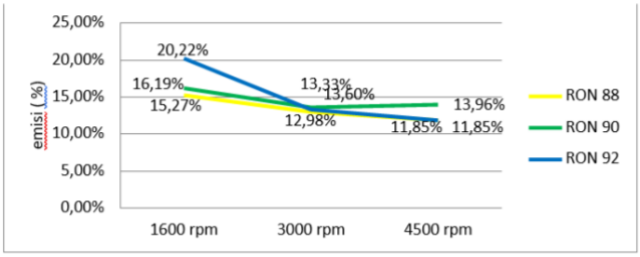

Figure. 5 Exhaust Emissions O2

Figure 5 shows the content of exhaust gas emissions of O2 at higher engine speeds, exhaust emissions tend to be lower on RON 88 and RON 92 fuels. Meanwhile, the content of exhaust gas emissions of RON 90 at 1600 rpm is higher than that of RON 88 and lower than that of RON 90. RON 92. So it can be concluded that the highest emission of O2 exhaust gas is RON 92 fuel, but the emission of O2 or oxygen exhaust gas is not harmful to the environment. Theoretically, the relationship between O2 content and engine speed is that at low engine speed the fuel flow rate is also lower so that the air and fuel mixture is less homogeneous and less perfect.

V. CONCLUSION

From the research results that have been described previously, the following conclusions can be drawn. An overview of CO exhaust emissions produced on a four-stroke motorcycle that uses RON 88 fuel which is higher than RON 90 and RON 92. Overview of HC exhaust emissions produced on four-stroke motorcycles that use RON 88 fuel which is higher than RON 90 and RON 92. The description of CO2 exhaust emissions in RON 88 fuel is higher than in RON 90 and RON 92, and the highest exhaust gas emissions of O2 are in RON 92 fuel compared to RON 90 and RON 88. However, CO2 and O2 exhaust emissions are not toxic so it is not harmful to the environment. The fuel with the lowest emission of harmful CO and HC is RON 92 fuel.

REFERENCES

[1] A. A Wira Kresna Ningrat, I. G. B Wijaya Kusuma, & I Wayan Bandem Adnyana 2016. Pengaruh Penggunaan Bahan Bakar Pertalite Terhadap Akselerasi dan Emisi Gas Buang Pada Sepeda Motor Bertransmisi Otomatis. Bali: Universitas Udayana.

[2] Ahmad Ansori Mattjik dan I Made Sumertajaya, 2002, Perancangan Percobaan Dengan Aplikasi SAS dan Minitab. Bandung: IPB Press.

[3] Anonim, 2003. Bahan bakar Minyak Elpiji dan BBG, pertamina.
[4] Arends, BPM dan Berenschot, H. 1980. Benzinemotoren. Alih bahasa: Umar Sukrisno. Motor Bensin. Jakarta: Erlangga.
[5] Arikunto, Suharsimi., 2006, Metode Penelitian: Prosedur Penelitian Suatu Pendekatan Praktik. Jakarta: CV. Rineka Cipta.
[6] Asthari, 2006. Pengaruh Penggunaan Spontan Power Terhadap Pemakaian Bahan Bakar Premium Pada Sepeda Motor Empat Tak. Skripsi. Makassar: FT-UNM.
[7] Asrullah, 2007. Pengaruh Perubahan Volume Ruang Bakar Dan Putaran Motor Terhadap Pemakaian Bahan Bakar Pada Sepeda Motor Dua Tak. Skripsi. Makassar: FT-UNM.
[8] Bachrani Sanusi. 1991, Hasil Tambang Minyak dan Gas Bumi Indonesia. UI pres.
[9] Daryanto, 2004. Teknik Sepeda Motor. Yogyakarta: CV. Yrama Widya.
[10] Fajar Bisnis. 11 Agustus 2017 Yamaha Kuasai 62% Pasar Roda Dua Sulsel, hlm.03.
[11] Ibrahim, Hasyim. 2000. Subsidi BBM Dari Dulu Sampai Sekarang. Bunga Rampai.
[12] Jama, Jalius dan Wagino. 2008. Teknik Sepeda Motor Jilid 1 Untuk SMK. Jakarta: Direktorat Pembinaan Sekolah Menengah Kejuruan. (Online), (http://pencintateknologi.blogspot.co.id/2013/03/cara-kerja-motor-4-tak_22.html?m=1 Diakses 29 November 2017).
[13] Juhana, Ohan. 1999. Teknik Reparasi Vespa. Bandung: Pustaka Setia.
[14] Kiyaku, Yawsaki dan Murdhana. DM, 1994. Teknik Praktis Merawat Sepeda Motor. Bandung: CV. Pustaka.
[15] Kompas.Com, 2016. Statistik Perhubungan. Makassar, Sulawesi Selatan. (Online), (Diakses 20 Oktober 2017).
[16] Peraturan Menteri Negara Lingkungan Hidup Nomor 05, Tahun 2006, Tentang Ambang Batas Emisi Gas Buang Kendaraan Bermotor Lama. Jakarta, 1 Agustus 2006.
[17] PP RI No. 41. 1999. Peraturan Pemerintah Republik Indonesia Nomor 41 Tahun 1999 Tentang Pengendalian Pencemaran Udara. (Online), (Diakses 20 Oktober 2017)
[18] Direktorat Pertamina. 2001, Bahan Bakar Minyak, Elpiji dan BBG. Pertamina Hilir Bidang Pemasaran dan Niaga Departemen Pengembangan Pasar BBM.
[19] Risqi Solekhah, 2016, Kualitas Bensin, Bilangan Oktan dan Dampak Pembakaran Minyak Terhadap Lingkungan. (online), (https://www.slideshare.net/rizqish/kulaitas-bensin-bilangan-oktan-dan-dampak-pembakaran-minyak-terhadap-lingkungan. Diakses 2 Desember 2017).
[20] Sucahyo, Bagyo. 1997. Otomotif Mesin Tenaga. Solo: PT. Tiga Serangkai.
[21] Sugiyono, 2016. Metode Penelitian Pendidikan Pendekatan Kuntitatif, Kualitatif, dan R&D. Bandung: Alfabeta.
[22] Swisscontact, 2001, Analisa Motor Bensin Berdasarkan Hasil Uji Emisi Gas Buang, Jakarta: Swisscontact.
[23] Wardono, 2004, Motor Bakar. Yogyakarta: CV. Pustaka
[24] Wiersma, William. 1991. Research Methods in Education: An Introduction. Boston: Allyn and Bacon. Jakarta.
[25] Wikipedia. 2017, Bilangan Oktan. (Online) (https://id.wikipedia.org/wiki/Bilangan_oktan. Diakses 2 November 2017).
[26] Wiranto Arismunandar. 2005. Penggerak Mula Motor Bakar Torak. Bandung: Institut Teknologi Bandung.
[27] Zainal. B, 2006. Studi Kesesuaian Spesifikasi Bahan Bakar Premuim SPBU Di Kota Makassar. Skripsi. Makassar: FT-UNM.
[28] Zainal, Arifin. Sukoco, 2009. Pengendalian Polusi Kendaraan. Yogyakarta: Alfabeta.